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X63-11374
Code 2D

TT F-8335

ON MEASUREMENT OF THE SPECTRAL DENSITY OF A NOISE IN GEOPHYSICS
APPLICATION TO THE EARTH IONOSPHERE CAVITY

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[redacted]

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON DECEMBER 1962

DRAFT TRANSLATION TT F-8335
DEC 11 1962

ON MEASUREMENT OF THE SPECTRAL DENSITY OF A NOISE IN GEOPHYSICS

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Comptes-Rendus A.Sc.
T. 255, No. 19, 2496-2498
PARIS, 5 November 1962

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The natural vlf emissions may be considered as a hazardous stationary process. The propagation theory of this noise in the 5 to 50 c.p.s. region was made by Raemer [1]. It foresees a spectrum offering a series of characteristic maxima of earth ionosphere cavity modes. We have shown in a preceding article [2] that spectral density may be measured by filtering and integration. Our results have been obtained with a summary device and aimed only to prove the possibility of utilizing a statistical method.

We started this work anew with the aid of a more elaborate installation. The Figures next page give two examples of spectra obtained from the latter. They allow the comparison of our results with those of Balser and Wagner (after Galejs [3]) who utilized a digital method [4], and with Galejs' theoretical results [3]. Two conclusions may be derived from these curves :

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* Sur la mesure de la densité spectrale d'un bruit en géophysique. Application à la cavité terre-ionosphère.

1) The Galejs' model, which starts from an exponential profile for electron densities of the lower ionosphere, lends itself remarkably for its application to experimental results;

2) Reciprocally one may think that this agreement constitutes a good test of the correctness of our spectral analysis method.

It may obviously be applied within a vast range of the frequency spectrum, and it will be of particular usefulness to "extract" the useful spectrum from an important background noise.

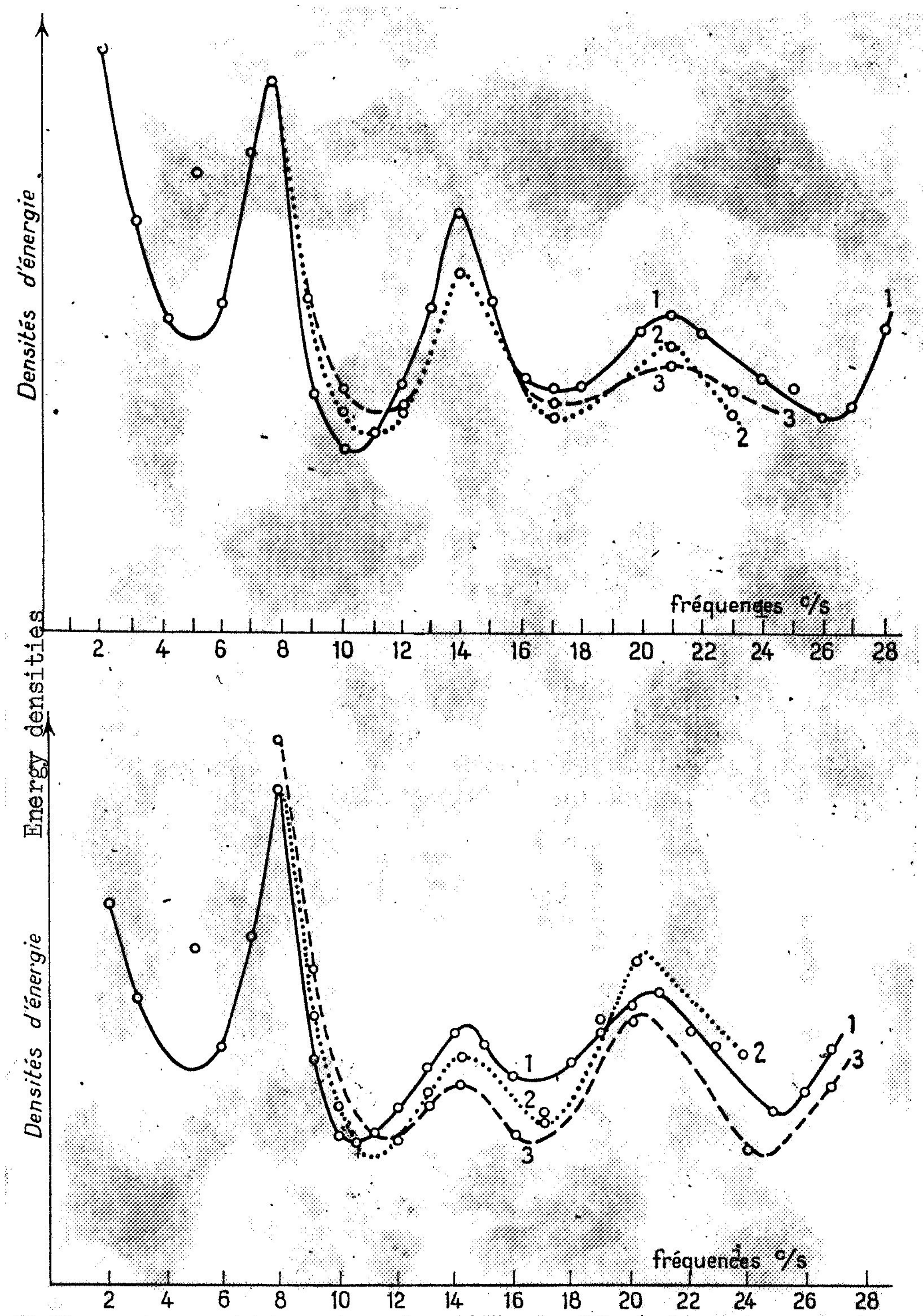
<u>METHOD OF ANALYSIS</u>. - Signals picked up with the aid of ann integrator-fluxmeter, were registered by M.Stefant on a magnetic tape, who was kind enough to lend us a copy.

The reading ofthe tape at a speed 40 times greater than that of the recording permits the measurements in the 40 – 1500 c.p.s. band. The reading signals V(t) are filtered by a selective amplifier, and then detected with a time constant of the order of a few seconds.

The rectified current thus obtained is registered while it is the object of analogical integration whose duration may be chosen at will. We thus obtain the quantity

$$M = \int_{t_0}^{t_1} |u(t)|\, dt.$$

We integrated during one hour. The study of the diurnal variation of the spectrum, made by Balser and Wagner, shows that the spectrum varies little during integration time.



1. Experimental results obtained by filtering and integration.
2. Experimental results by Balser and Wagner.
3. Theoretical curve by Galejs.

To simplify, let us postulate $t_1 - t_0 = 1$.

This is a stationary process and $u(t)$ varies little.

Under these conditions

$$M^2 \simeq \int_{t_0}^{t_1} |u(t)|^2 dt \quad \text{or} \quad M^2 = \overline{|u(t)|^2}.$$

According to the Parseval theorem :

$$M^2 = 2\int_0^\infty F^2(N, N_1) P(N) dN,$$

$P(N, N_1)$ being the signal's spectrum after passage in a filter centered on N_1 (cf [5]).

Let $F(N, N_1)$ be the transfer function of this filter

$$\overline{|u(t)|^2} = 2\int_0^\infty P(N, N_1) dN, \qquad (1)$$

$P(N)$ is the spectral density of the studied signal $V(t)$.

If we select a filter such that $P(N)$ varies little in the pass band N centerd on N_1, (1) is written

$$M^2 \simeq 2P(N_1) S(N_1), \qquad (2)$$

with

$$S(N_1) = \int_{N_1 - \frac{\Delta N_1}{2}}^{N_1 + \frac{\Delta N_1}{2}} F^2(N, N_1) dN,$$

Thus, the equation (2) gives the quantity $P(N_1)$, starting with the experimental result M, so long as we evaluate $S(N_1)$ by plotting the filter response curve starting from a low-frequency generator.

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for the

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

11 December 1962